Element Information: Gadolinium

Gadolinium

64 **Gd** 157.25		
	Atomic Number	64
	Atomic Weight	157.25
	Electron Config.	2-2-6-2-6-10-2-6-10-7-2-6-1-0-2

Electron configuration order: *1s-2s-2p-3s-3p-3d-4s-4p-4d-4f-5s-5p-5d-5f-6s-6p-6d-7s*

Mechanical Properties		**Conditions**		
		Phase	**Temp.** (K)	**Pressure** (Pa)
Density	7900 kg/m^3	Solid	298.15	0
* Modulus of Elasticity	75.842 GPa	Solid	0	
Poisson Ratio	0.26	Solid		
Thermal Expansion Coefficient	9.000×10^{-6} /K	Solid	298.15	

Electrical Properties		**Conditions**	
		Temp. (K)	**Note**
Electrical Resistivity	1.405×10^{-6} Ω-m	298.15	

Thermal Properties		**Conditions**	
		Temp. (K)	**Pressure** (Pa)
Melting Temperature	1587.15 K		101325
Boiling Temperature	3537.15 K		101325
Critical Temperature	8670 K		
Fusion Enthalpy	62.4 J/g	0	101325
Heat Capacity	236 J/kg-K	298.15	100000
Thermal Conductivity	10.5 W/m-K	300 more...	101325

FORT WAYNE METALS

Nitinol

Melt Practice

Nitinol is a family of alloys which are comprised of near equiatomic percentages of nickel and titanium. A few variants of Nitinol also include small amounts of a third element that is used to alter certain properties. Nitinol exhibits a thermoelastic martensitic transformation. This transformation is responsible for either shape memory or superelasticity being exhibited by the alloy. Following deformation below the transformation range, the ability called shape memory allows recovery of a predetermined shape upon heating above the transformation range. Superelasticity is the ability to recover a shape upon removal of an applied stress over a narrow range of deformation temperatures. The strain recovered with shape memory or superelasticity provides nearly ten times the elastic springback of other alloys such as stainless steel.

Typical Chemistry

	FWM NiTi #1	FWM Avg.
Nickel	54.5-57.0 wt. %	56.0 wt %
Carbon	0.050 wt % Max.	0.033 wt % Max.
Oxygen	0.050 wt % Max.	0.028 wt % Max.
Hydrogen	0.005 wt % Max.	0.0025 wt % Max.
Titanium	Balance	Balance

In addition to FWM's NiTi #1 (High Nickel Superelastic Binary), requirements for a variety of binary and ternary chemistries can be made available.

Physical Properties

These values are typical for FWM NiTi#1

	Austenite	Martensite
Density	6.45 g/cm 3	6.45 g/cm 3
* **Modulus of Elasticity**	75GPa	40GPa
Electrical Resistivity	82x10 -6 ohm-cm	76x10 -6 ohm-cm
Magnetic Susceptibility	3.7x10 -6 emu/g	2.4x10 -6 emu/g
Coefficient of Thermal Expansion	11x10 -6 /°C	6.6x10 -6 /°C

Transformation Properties

Because shape memory and superelasticity are very temperature dependent, there are a number of thermal points of interest that deserve discussion in order to gain an understanding of the material. This paper will discuss two of these points: the fully annealed austenitic peak and the active austenitic finish temperatures. The fully annealed austenitic peak (A p) is a temperature that FWM uses in order to classify the types of Nitinol. Several companies will make use of different points, but the intent of the measurements are the same. The A p is the point that the fully annealed Nitinol has the highest rate of transformation from Martensite to Austenite. The active austenitic finish temperature (Active A f) is a finished material property that is measured after heat treatment. This is the temperature at which the material has completely transformed to Austenite, which means that at and above this temperature the material will have completed its shape memory transformation or will display its superelastic characteristics. For a more detailed discussion of thermal properties and the effect that they may have on your finished product, please feel free to contact FWM.

Fully Annealed Austenitic Peak (A_p) by Differential Scanning Calorimeter	-25 to -5 °C
Active Austenitic Finish (A_f) by bend and free recovery	10 to 20 °C

Product Forms

Round Wire: Size Range .0005" up to .250"
Flat Wire: Minimum thickness down to .0003"
Strands and Cables: Nitinol is available in all of our standard strand configurations.
DFT (drawn filled tubing): Please call FWM regarding your DFT needs.
Turkshead and Specialty Shapes: FWM has recently added the capability to manufacture your square, rectangle or other shaped cross-sectional wire needs.

Surface Finishes

Light Oxide: (LO) Gold to Brown color - diamond drawn surface
Dark Oxide: (DK) Grey to Black color - diamond drawn surface
Black Oxide: (BLK) Shiny Black color - diamond drawn surface

Etch: (E) chemical removal of oxide layer - will retain smooth surface
Pickled: (P) chemical removal of oxide layer along with a slight amount of base metal - surface will have a rough texture
Etched and Mechanically Polished: (EMP) Chemical removal of oxide layer followed by mechanical polish - surface will have stainless steel appearance (although at >40x magnification, micro scratches will be present)

Mechanical Properties (at 21 +/- 3°C)

Two critical characteristics unique to Nitinol in the austenitic phase are the loading plateau and the unloading plateau. The loading plateau stress is the stress level at which material at a specific temperature above A_f will force Austenite phase into Martensite. This produces an almost constant stress level over a relatively large range of strain, up to about 8%. The unloading plateau stress is the stress level at which the Martensite will return to the Austenitic phase.

Lead

82	Atomic Number	82
Pb	Atomic Weight	207.2
207.2	Electron Config.	2-2-6-2-6-10-2-6-10-14-2-6-10-0-2-2

Electron configuration order: *1s-2s-2p-3s-3p-3d-4s-4p-4d-4f-5s-5p-5d-5f-6s-6p-6d-7s*

Mechanical Properties		**Conditions**		
		Phase	**Temp. (K)**	**Pressure (Pa)**
Density	11300 kg/m^3	Solid	298.15	0
Modulus of Elasticity	13.79 GPa	Solid	0	
Poisson Ratio	0.44	Solid		
Thermal Expansion Coefficient	2.890×10^{-5} /K	Solid	298.15	

Electrical Properties		**Conditions**	
		Temp. (K)	**Note**
Electrical Resistivity	2.065×10^{-7} Ω-m		

Thermal Properties		**Conditions**	
		Temp. (K)	**Pressure (Pa)**
Melting Temperature	600.61 K		101325
Boiling Temperature	2022.15 K		101325
Critical Temperature	5500 K		
Fusion Enthalpy	23 J/g	0	101325
Vaporization Enthalpy	866.31 J/g	0	101325
Heat Capacity	129 J/kg-K	298.15 more...	100000
Thermal Conductivity	35.3 W/m-K	300 more...	101325